Nonbattle Injury Among Deployed Troops: An Epidemiologic Study

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ABSTRACT (n = 150) Nonbattle injury (NBI) continues to be a leading cause of morbidity among troops currently deployed to Iraq and Afghanistan. To assess NBI incidence, impact, and risk factors, a survey was given to soldiers during mid- or postdeployment from Iraq, Afghanistan, and surrounding region, from January 2005 through May 2006. Among 3,367 troops completing a survey, 19.5% reported at least one NBI, and 85% sought care at least once for their symptoms. Service component, rank, and unit type were among factors associated with differential NBI risk. Twenty percent stated that NBI resulted in back-up personnel being called or shift change to cover impacted duties, and among those reported having been grounded from flight status, a third were the result of NBI. NBI continues to be a problem in recent deployments, and given the findings on individual and potential operational impact indicators, NBI should be viewed as a primary force health protection problem.

INTRODUCTION

The United States military is currently undergoing transformation into a smaller, more mobile armed force to meet the demands of the 21st century.[1] This reduction in size has subsequently placed greater importance on the individual combatant and has increased the military's dependence on the personal readiness of each member. In the military's current configuration, both combat casualties and disease and nonbattle injury (DNBI) stand to have more impact on operational readiness than ever before. In recent conflicts, nonbattle injury (NBI) has represented a sizable portion of the echelon I, echelon II, and echelon III medical care provided in combat situations.[2–8] A single published report from Iraq and Afghanistan showed NBIs were three to six times more common than medical evacuations for combat injuries.[3] Previous NBI rates from recent operations have ranged between 4.6 and 11.6 (median 7.2) injuries per 100 person-months.[5,6,8–11]

Prior research efforts have concentrated primarily on determining the NBI rate and patterns across the armed forces involved in a conflict on the basis of medical treatment facility (MTF) encounter data. However, this strategy of data collection from aid stations, clinics, or hospital visits tends to underestimate the entire spectrum of disease and injury burden by failing to include incidence and morbidity for visits not captured by military medical treatment facilities (e.g., that which is treated by medics, corpsmen, self- or buddy-aid). In a prior study reported by Sanders et al., with data collected from January to March 2004, the rates and impact of DNBI for combatants in both OIF and OEF were reported.[10] Data pertaining to DNBI were collected from forces leaving the theater of operations or while on recreational leave during the middle of deployment. This novel approach for collecting data not only accounts for those individuals who had sought care at medical facilities during their operational tour, but also those who did not seek care and would have otherwise not been included in previous DNBI estimates. Specifically, nonbattle injury was reported among 34% of the troops reporting with 77% reporting seeking care multiple times. The impact of these injuries on the mission can contribute to significant health care utilization and decreased performance. For instance, 21% of the respondents in the previous study reported that their NBI required immobilization or splinting, and 17% received narcotics for pain.

To further describe incidence and morbidity for nonbattle injury during recent combat operations, as well as define important risk associations, a follow-up survey was conducted among troops on deployment in Iraq, Afghanistan, and the surrounding region.

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The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the U.S. Navy, U.S. Air Force, the Uniformed Services University of the Health Sciences or Department of Defense.

This is a primary data analysis of survey responses collected from U.S. military personnel deployed to Iraq, Afghanistan, and the surrounding region under NAMRU-3 DoD approved protocol. There are no personal identifiers included in these data. Surveys were limited to one page and were completely voluntary and anonymous. This study received IRB exemption from the Uniformed Services University of the Health Sciences.

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METHODS

Study Subjects

In 2005 and 2006, Defense Manpower Data Center reported that approximately 165,700 and 207,000 soldiers deployed to Iraq and approximately 23,000 deployed to Afghanistan per year.[12] Military personnel leaving Iraq or Afghanistan at the completion of their deployment or who were participating in a mid-deployment rest and recuperation (R&R) program during the study period (January 26, 2005–May 25, 2006) were eligible for participation.

Study Sites

Study personnel were placed in the terminal of Incirlik Air Base, Turkey, and in redeployment stations at Camp Arifjan, Kuwait, which are commonly used as staging points to and from Iraq and Afghanistan. Additionally, study personnel were stationed at Camp As Sayliya, Doha, Qatar, the primary site for the U.S. Central Command R&R in-theater pass program. Study personnel conducted a convenience sampling of troops who were transiting these sites. Troops were met as they exited the planes, during redeployment, or during R&R processing and were asked to participate in the study.

Study Questionnaire

Similar to previously published studies, we utilized a large questionnaire (148 questions), designed to evaluate a broad range of health threats and concerns among the deployed population, which was subdivided into 12 single-page forms to minimize the operational impact of such an instrument within a deployed setting.[10] Researchers sequentially distributed the 12 different study forms to the participants (e.g., every 13th person in a group received the same form) and subsequently collected the completed forms. Each volunteer completed only one form and participation was voluntary and anonymous. The single-page forms were composed of 11 demographic questions that were found on every form and 10–24 additional questions that were unique to each form. The identical demographic questions were placed on multiple forms to later test for internal survey validity. Two of the forms were designed with questions to evaluate NBI incidence, cause, and impact. Both forms asked respondents for frequency of NBI based on increasing categories (0, 1, 2–3, 4–5, 6–7, ≥8 injuries). For the most severe injury, cause was asked as well as duration (range 1 to >14 days). On one of the two forms, frequency of seeking care was similarly ascertained (range 0 to ≥5 visits) as was confinement to quarters (bedrest) or being placed on light duty, decrease in job performance, and hospitalization were assessed (dichotomous). Duration of confinement to quarters/light duty, job performance impact, and hospitalization duration were also ascertained (range 1 to ≥7 days) on one of the forms. Potential indicators of operational impact were assessed through questions regarding missing patrols, being grounded (if on flight status), and medical evacuation.

Data Entry and Analysis

Data were double entered into MS Access and exported to an MS Excel spreadsheet (Microsoft, Redmond, WA). Data accuracy and data integrity checks were performed on questionnaires. For statistical testing of continuous variables, normality testing was conducted, followed by either parametric (Student's t-test or ANOVA) or nonparametric (Kruskal-Wallis test). Categorical variables (proportions) were tested using χ^2 or Fisher's exact tests. Time in theater was calculated for each individual. To estimate NBI incidence the number of self-reported injuries or visits associated with NBI were treated as the numerator, with person time in country as the denominator. For subjects where missing time in theater was found (19.7%), time in country was imputed on the basis of a multivariable model predicting missing data.[13] The Poisson distribution assumption of mean equal to variance was not met (mean = 0.35, variance = 0.82) and, therefore, a negative binomial regression model was used to estimate incidence and 95% confidence intervals (95% CI). Bivariate and multivariate analyses for association between primary outcomes and explanatory variables were conducted using negative binomial regression. Multivariable models were fit using a forward step-wise technique with criteria for entry of $p < 0.15$ in the bivariate analysis. Stata version 9 statistical software (Stata, College Station, TX) was used for all statistical analysis and all statistical tests were two tailed and significance was defined as $p < 0.05$.

RESULTS

From January 26, 2005 to May 25, 2006, a total of 3,367 surveys (from two NBI-related forms of 1,670 and 1,697 respondents) were completed by 2,355 (69.9%) service members from Operation Iraqi Freedom, 644 (19.1%) from Operation Enduring Freedom, and from 302 (8.9%) who stated they were supporting both OIF and OEF. Individual theater arrival dates were reported between February 7, 2003 and February 17, 2006. Of those participating in the survey, the median age was 26 (interquartile range [IQR] 22–35) years, with reservists and National Guard members being older than regular active duty (median age 30, 31, and 24 years, respectively) and 85.6% were male. Ground forces made up 30.3% while support and command forces comprised 52.5%. The Army represented the bulk of survey recipients with 2,594 (77.0%) followed by the Marine Corps ($n = 432$, 12.8%) and the Navy ($n = 241$, 7.2%). The majority of survey recipients were junior-grade enlisted ($n = 1,657$, 49.2%), followed by midgrade enlisted ($n = 1,102$, 32.7%), officer/chief warrant officer ($n = 336$, 10.0%), and senior enlisted ($n = 259$, 7.7%). Further data regarding survey demographics can be found in Table I.

Overall 19.5% of surveyed troops (657/3,367) reported at least one NBI, with 38.8% (254/657) reporting multiple NBIs. Median deployment duration was 6.3 (IQR 4.7–8.4) months. On the basis of self-reported NBI and person-time for the sample population, overall incidence of NBI was estimated to be 5.2 (95% CI 4.8–5.7) injuries per 100 person-months.

TABLE I. Population Characteristics of Sample Population Stratified by Service Component

Characteristic	Service Component			
	Regular Active Duty(N = 1,770)	Reserve(N = 776)	National Guard(N = 821)	Total(N = 3,367)
Median Age in Years (IQR)	24 (21–30)	31 (24–39)	30 (23–38)	26 (22–35)
Male Gender, *n* (%)	1,527 (86.3)	634 (81.7)	720 (87.7)	2,881 (85.6)
Current Operation, *n* (%)				
OIF	1,200 (67.8)	545 (70.2)	610 (74.3)	2,355 (69.9)
OEF	357 (20.2)	124 (16.0)	163 (19.9)	644 (19.1)
Both	168 (9.5)	98 (12.6)	36 (4.4)	302 (8.9)
Other	13 (0.7)	3 (0.4)	3 (0.4)	19 (0.6)
Days Deployed, Median (IQR)	183 (134–231)	208 (158–280)	215 (151–289)	195 (142–256)
Service Branch, *n* (%)				
Army	1,220 (68.9)	586 (75.5)	788 (96.0)	2,594 (77.0)
Air Force	64 (3.6)	1 (01)	25 (3.1)	90 (2.7)
Marine Corp	384 (21.7)	47 (6.1)	1 (0.1)	432 (12.8)
Navy	99 (5.6)	142 (18.3)	0 (0.0)	241 (7.2)
Other	0 (0.0)	0 (0.0)	6 (0.7)	6 (0.2)
Rank, *n* (%)				
Junior Enlisted (E1–E4)	1,032 (58.3)	266 (34.3)	359 (43.7)	1,657 (49.2)
Midgrade Enlisted (E5–E6)	454 (25.7)	354 (45.6)	294 (35.8)	1,102 (32.7)
Senior Enlisted (E7–E9)	102 (5.8)	68 (8.8)	89 (10.8)	259 (7.7)
Officer/Chief Warrant	174 (9.8)	84 (10.8)	78 (9.5)	336 (10.0)
Unit Type, *n* (%)				
Command	113 (6.4)	41 (5.3)	48 (5.9)	202 (6.0)
Ground	502 (28.4)	160 (20.6)	357 (43.5)	1,019 (30.3)
Air	211 (11.9)	30 (3.9)	41 (5.0)	282 (8.4)
Support	801 (45.3)	444 (57.2)	319 (38.9)	1,564 (46.5)
Special Ops	39 (2.2)	50 (6.4)	10 (1.2)	99 (2.9)
Other	83 (4.7)	45 (5.8)	35 (4.3)	163 (4.8)
Prior Deployment				
OIF	358 (20.2)	38 (4.9)	35 (4.3)	431 (12.8)
OEF	138 (7.8)	63 (8.1)	67 (8.2)	268 (8.0)
Both	166 (9.4)	41 (5.3)	18 (2.2)	225 (6.7)
Neither	1,093 (61.8)	630 (81.2)	691 (84.2)	2,414 (71.7)

Subtotals for each variable may not add up to 100% because of missing data. IQR, interquartile range; OIF, Operation Iraqi Freedom; OEF, Operation Enduring Freedom.

NBI self-reported as "most severe" was attributed in 68% of the observations, with sports/athletics and heavy gear/lifting being primary causes (22.3% and 19.6%, respectively). Of the three top causes of most severe NBI (sports/athletics, heavy gear/lifting, and other), there were few differences in service member characteristics and outcomes (Table II). A severe injury because of sports/athletics was attributed more frequently in OEF (46%) compared to personnel describing their current operation in support OIF (26.5%) or both OEF and OIF (33.3%). Decreased job performance associated with most severe injuries were less frequently reported with sports/athletic NBI (29.2%) compared to heavy gear/lifting (51.6%) or other severe NBI (42.7%) ($p = 0.03$).

Table III details self-reported individual and operational impact of nonbattle injuries incurred in the study population from questions that were asked on one of the two forms. Among 336 reporting a NBI, 285 reported seeking medical care (84.8%). Decreased job performance as a result of a NBI was reported in 42.2% of NBI, which lasted on average 6 days. Thirty-six percent of troops (not mutually exclusive from decreased performance) reported being placed on light duty for an average of 6 days, and overall 5.4% reported being hospitalized for a NBI for an average of 3 days. Of those who reported as being on flight status, 5.2% stated they were grounded because of a NBI. A total of 2.4% reported having been medically evacuated because of a NBI. Overall there were multiple visits per NBI resulting in an estimated 5.8 (95% CI 5.0–6.7) NBI-related visits to "medical" per 100 person-months.

Several associations were noted for differential injury incidence in bivariate analysis (Table IV). Increasing age (per 10-year increase) was associated with an increased incidence rate ratio (IRR) of 1.2 ($p = 0.002$). The IRR for reservist and National Guard was higher (1.4; $p = 0.001$), compared to their active component counterparts. Deployment in support of both OIF and OEF was found to be associated with an increased incidence (IRR = 1.4, $p = 0.03$) and prior deployment in support of both operations tended toward statistical significance (IRR = 1.5, $p = 0.06$). Ground (IRR = 1.8, $p = 0.01$) and support units (IRR = 1.7, $p = 0.02$) were associated with increased NBI incidence rate in comparison to command units, whereas special operations was also associated with a nearly doubling of NBI risk (IRR = 1.9, $p = 0.06$) but did not achieve statistical significance. Only the midgrade enlisted rank category proved

TABLE II. Selective Population Characteristics and Measures of Nonbattle Injury Impact Stratified By Three Most Frequently Reported Mechanisms

Characteristic	Cause of Injury		
	Sports/Athletics (N = 75)	Heavy Gear/Lifting (N = 66)	Other (N = 106)
Median Age in Years (IQR)	31 (25–37)	32 (23–38)	29 (24–37)
Male Gender, *n/N* (%) [NS]	63/73 (86.3)	49/64 (76.6)	84/103 (81.6)
Current Operation, *n* (%) [p = 0.09]			
OIF (N = 170)	45 (26.5)	49 (28.8)	76 (44.7)
OEF (N = 37)	17 (46.0)	10 (27.0)	10 (27.0)
Both (N = 30)	10 (33.3)	5 (16.7)	15 (50.0)
Service Branch, *n* (%) [NS]			
Army (N = 196)	57 (29.1)	55 (28.1)	84 (42.9)
Air Force (N = 3)	1	2	0
Marine Corp (N = 20)	8 (40.0)	3 (15.0)	9 (45.0)
Navy (N = 20)	6 (30.0)	4 (20.0)	10 (50.0)
Other			
Rank, *n* (%) [NS]			
E1–E4 (N = 84)	25 (29.8)	23 (27.4)	36 (42.9)
E5–E6 (N = 104)	29 (27.9)	32 (30.8)	43 (41.4)
E7–E9 (N = 19)	6 (31.6)	2 (10.5)	11 (57.9)
Officer/Warrant	12 (37.5)	7 (21.9)	13 (40.6)
Unit Type, *n* (%) [NS]			
Command (N = 13)	7 (53.9)	1 (7.7)	5 (38.5)
Ground (N = 76)	20 (26.3)	19 (25.0)	37 (48.7)
Air (N = 8)	2	1	5
Support (N = 122)	35 (28.7)	39 (32.0)	48 (39.3)
Special Ops (N = 6)	2	2	2
Other (N = 15)	7 (46.7)	2 (13.3)	6 (40.0)
Decreased Job Performance, *n/N* (%) [p = 0.03]	21/72 (29.2)	33/64 (51.6)	44/103 (42.7)
Placed on light duty, *n/N* (%) [NS]	23/72 (31.9)	26/64 (40.6)	38/103 (36.9)
Hospitalized, *n/N* (%) [NS]	3/72 (4.2)	1/63 (1.6)	6/103 (5.8)

NS, not significant; IQR, interquartile range; OIF, Operation Iraqi Freedom; OEF, Operation Enduring Freedom.

to increase NBI incidence (IRR = 1.7, $p < 0.0001$). Hygiene infrastructure also showed a significant association with NBI incidence being higher among troops reporting less developed infrastructure (chemical or burn-out latrine IRR = 1.4, p = 0.001; slit, trench, or no latrine IRR = 2.1, p = 0.02; referent, flush toilets; data not shown). No differential NBI incidence was associated with gender or service branch.

In multivariate analysis, age, prior deployment, and unit type failed to retain significance. Service component seemed to play an important role in the incidence of NBI with National Guard members gaining a significant increase in risk of IRR = 1.3 (p = 0.04) compared to regular active duty personnel, whereas being a reservist did not retain an association with differential NBI risk. In multivariate analysis deploying in support of both OIF and OEF (IRR = 1.5, p = 0.005) and being midgrade enlisted (IRR = 1.5, p = 0.001) remained statistically significant in the model. Senior enlisted tended toward an increase risk of NBI (IRR = 1.4, p = 0.09), as did troops reporting to belong to support (IRR = 1.5, p = 0.08) and special operations units (IRR = 1.6, p = 0.1) compared to command units. Estimates of increased risk on the basis of hygiene infrastructure remained stable and significant (chemical or burn-out latrine IRR = 1.40, p = 0.001; slit, trench, or no latrine IRR = 2.06, p = 0.02; referent, flush toilets; data not shown).

DISCUSSION

The self-reported incidence of NBI in the sample population was estimated at 5.2 events per 100 person-months. This incidence rate is lower compared to the self-reported incidence reported among troops on similar deployment (OIF/OEF) during 2003–2004 reported by Sanders et al. (8.6 NBI per 100 person-months).[10] The reasons for this lower incidence may be the result of the way it was estimated (though questions were similarly asked between surveys), a different sample population, or the result of a real decrease in NBI incidence compared to early periods in the military operation. The higher incidence rate seen in the 2003–2004 study may be attributed to the concurrent combat operations phase during which the incidence of NBI was significantly increased in comparison to postcombat operations.[10,14] Similar to the previous study in this population and deployment, a large proportion of NBI resulted in seeking care (approximately 85%) and many injuries required multiple visits resulting in an estimate of 5.8 (95% CI 5.0–6.7) NBI visits per 100 person-months.[10] These data support that the individual and health care burden associated with NBI is quite high.

In this study, there were a number of factors that were associated with an increased risk of NBI. Deployment to both OIF and OEF has a statistically significant increased risk of NBI, likely reflecting an increased mobility and/or exposure

TABLE III. Description of Cause and Impact of NBI Among Deployed U.S. Troops in Support of OIF and OEF

Parameter	Estimate
Cause of Most Severe NBI, *n/N* (%)	
Sports/Athletics	75/336 (22.3)
Heavy Gear/Lifting	66/336 (19.6)
Fall	43/336 (12.8)
Machinery/Tools	32/336 (9.5)
Vehicle Accident	14/336 (4.2)
Other	106/336 (31.6)
Median Duration of Most Severe NBI, Days (IQR)	7 (4–15)
Individual Impact of NBI	
Incidence of NBI Reporting Visit per 100 Person-Months (95% CI)	5.2 (4.8–5.7)
NBI Resulting in at Least One Visit to "Medical," *n/N* (%)	285/336 (84.8)
Incidence of All Visits for NBI per 100 Person-Months (95% CI)	5.8 (5.0–6.7)
NBI Result in Decrease in Job Performance, *n/N* (%)	141/334 (42.2)
No. of Days of Decreased Job Performance, Median (IQR)	6 (3–8)
NBI Result Placement on Light Duty, *n/N* (%)	121/333 (36.3)
No. of Days Light Duty, Median (IQR)	6 (3–8)
NBI Result in Hospitalization, *n/N* (%)	18/332 (5.4)
Length of Stay, Median (IQR)	3 (1.5–6)
Operational/Mission Impact of NBI	
NBI Resulted in Back-Up Personnel or Shift Change to Cover Duties, *n/N* (%)	59/307 (19.2)
Ever Miss Patrol Because of NBI, *n/N* (%)	31/596 (5.2)
Ever Miss Patrol Because of Any Illness or Injury, *n/N* (%)	70/610 (11.5)
On Flight Status *n/N* (%)	80/1,657 (4.8)
Grounded Because of NBI, *n/N* (%)	4/77 (5.2)
Grounded for Any Reason, *n/N* (%)	12/79 (15.2)
Medically Evacuated for a NBI, *n/N* (%)	38/1,611 (2.4)
Medically Evacuated for Any Illness or Injury, *n/N* (%)	47/1,615 (2.9)

NBI, nonbattle injury; CI, confidence interval; IQR, interquartile range; OIF, Operation Iraqi Freedom; OEF, Operation Enduring Freedom.

window in which service members are likely to be injured or diseased. It was also reported that midgraded enlisted personnel had a significant increase in NBI IRR as compared to the junior enlisted, possibly indicating an increase in hazardous activities in which injury or disease is likely to result. Compared to command units, both support and special operations units were associated with an increased incidence. On the basis of the frequency distribution of cause of injury across unit types (data not shown), these units had higher rates of injuries associated with heavy gear and lifting (support 24%, special operations 20% versus command 6%). Special operations units were also noted to have higher rates of injuries associated with vehicle accidents compared to all other unit types, though cause of injury among special operations unit participants were based on only a few observations. Sports and recreation injuries were twice as common in the command unit (44%) compared to other unit types (17–21%). The overall rate of NBI injury because of sports and recreation (22%) was similar to that reported in the Sanders et al. study (23%).[10]

National Guard troops also showed a 30% increase in risk of NBI compared to other deployed populations. The reason for this increased risk is uncertain (not related to age), but could be the result of differences in occupations or to poorer physical readiness before deployment. In a study by Lorich et al., investigating a sudden 167% increase in line of duty injuries (LOD) occurring in an Air National Guard unit during active duty and annual training, they found a concurrence between overweight and excessive BMI in males and LOD injuries.[15] Furthermore, a study by Bell et al., found that higher injury rates among females at Army basic training was a result of their initial cardiovascular fitness level.[16] These data may suggest that differential conditioning or physical fitness in National Guard troops may be contributing to the increased rates of NBI. Future studies should consider evaluating this possible association.

Beyond determination of differential risk associations for NBI is the impact that these health events have on the individual troop and the operational readiness of deployed units. Whether one is impacted by being confined to quarters, put on light duty or hospitalized, our survey suggests that 42% of troops with NBI reported decreased performance. At many times, the impact of these lost duty days was felt beyond the individual, as in 19% of incapacitating NBIs, backup personnel were called in or there was a shift change to fill the vacated duties. Many service members with NBIs were so severely injured that they required medical evacuation, and in our sample, NBIs represented 81% of all self-reported medical evacuations occurring for any illness or injury. Prior studies from OIF in 2003 have shown similar results with 87% of all medical evacuations resulting from disease and nonbattle injury.[17]

This study is not without limitation, and bias or errors in design must be considered. Our estimates related to medical evacuation may be an underestimate, as those who were evacuated and not returned to duty because of their NBI would not have been sampled in our study. Because of the way the data were collected, on a per-deployment basis rather than a per-injury basis, we were unable to estimate NBI rates comparable to those of recent historical combat operations, which are collected using passive clinic-based DNBI weekly surveillance which records only the initial visit. In our study, we recorded information on multiple NBI and multiple NBI-associated visits to "medical," which were not limited to initial visit for a given injury. Studies should be conducted on traditional DNBI surveillance data to estimate the incidence of NBI in current operations compared to historical rates. Of those who did participate in the survey, volunteer or recall bias may have been present. Additionally, of those who were on R&R, it would be assumed that passes were distributed evenly among units; however, the nonsystematic distribution of passes would affect the generalizability of the sample given the heavy reliance on the R&R population. Furthermore, we noted that age appeared to confound the relationship between

TABLE IV. Bivariate and Multivariate Negative Binomial Regression for Differential Nonbattle Injury Risk

	Bivariate			Multivariate		
Covariate	IRR	95% CI	*P*	IRR	95% CI	*P*
Age in 10-Year Increments	1.2	(1.1–1.3)	0.002			
Male Gender	1.0	(0.7–1.2)	0.7			
Component						
Regular	Referent	—		Referent	—	
Reserve	1.4	(1.2–1.8)	0.001	1.1	(0.9–1.4)	0.3
National Guard	1.4	(1.2–1.8)	0.001	1.3	(1.0–1.6)	0.04
Current Operation						
OIF	Referent	—		Referent	—	
OEF	0.9	(0.7–1.2)	0.6	1.1	(0.9–1.4)	0.5
Both	1.4	(1.0–1.9)	0.03	1.5	(1.1–2.1)	0.005
Neither	0.0	(ND)	>0.95			
Service Branch						
Army	Referent	—				
Air Force	0.5	(0.3–1.0)	0.07			
Marine Corps	0.7	(0.5–0.9)	0.006			
Navy	0.9	(0.6–1.2)	0.4			
Other	2.7	(0.5–16.1)	0.3			
Rank						
Junior Enlisted (E1–E4)	Referent	—		Referent	—	
Midgrade Enlisted (E5–E6)	1.7	(1.4–2.0)	<0.0001	1.5	(1.2–1.8)	0.001
Senior Enlisted (E7–E9)	1.3	(0.9–1.8)	0.2	1.4	(1.0–1.9)	0.09
Officer/Chief Warrant	1.1	(0.8–1.6)	0.4	1.2	(0.9–1.6)	0.3
Unit Type						
Command	Referent	—		Referent	—	
Ground	1.8	(1.1–2.7)	0.01	1.5	(0.9–2.3)	0.9
Air	0.9	(0.9–1.5)	0.6	1.3	(0.7–2.2)	0.4
Support	1.7	(1.1–2.5)	0.02	1.5	(1.0–2.3)	0.08
Special Ops	1.9	(1.0–3.5)	0.06	1.6	(0.9–3.1)	0.1
Other	1.5	(0.9–2.7)	0.2	1.6	(0.9–2.7)	0.1
Prior Deployment						
OIF	Referent	—				
OEF	1.0	(0.6–1.5)	0.9			
Both	1.5	(1.0–2.2)	0.06			
Neither	1.2	(0.9–1.5)	0.3			

CI, confidence interval; OIF, Operation Iraqi Freedom; OEF, Operation Enduring Freedom.

NBI and rank. It is possible that associations between covariates used in our model may not be true, rather representing a surrogate measure for some other unmeasured risk factor. Our survey particularly lacked information on occupation, prior injury history, and other medical comorbidities, which may have been important factors for NBI. Finally, we did not explore interactions between covariates, though further analyses are planned.

CONCLUSION

In this study, 20% of surveyed troops reported at least one NBI, with 39% reporting multiple NBIs. The estimated overall incidence of NBI was 5.2 injuries per 100 person-months. For NBI reported as being "severe," sports/athletics, heavy gear/lifting, and falls were the most common causes. Though few injuries resulted in medical evacuation, almost 20% reported that the NBI resulted in having to call in back-up personnel or change a shift to cover duties. Multivariate analysis showed increased risk for NBI among National Guard, troops who have served in both OIF and OEF, and midgrade enlisted service members, compared to other components, single theater or no deployment, and other ranks, respectively. Whether NBI directly impacts military operations is uncertain; however, given the findings on individual and potential operational impact indicators, NBI should be viewed as a force health protection problem worthy of future study and intervention implementation.

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REFERENCES

1. Kern PJ: Technology, transformation and war - a kaleidoscope of force. Army 2003; 53: 63–6.
2. Blood CG, Jolly R: Comparisons of disease and nonbattle injury incidence across various military operations. Mil Med 1995; 160: 258–63.

3. Hawley-Bowland CG: Casualty Analysis: Health Policy and Services. Washington DC, U.S. Army Medical Command, 2004.
4. Kilian DB, Lee AP, Lynch L, Gunzenhauser J: Estimating selected disease and nonbattle injury Echelon I and Echelon II outpatient visits of United States soldiers and Marines in an operational setting from corresponding Echelon III (hospitalizations) admissions in the same theater of operation. Mil Med 2003; 168: 293–7.
5. Miser WF, Doukas WC, Lillegard WA: Injuries and illnesses incurred by an army ranger unit during Operation Just Cause. Mil Med 1995; 160: 373–80.
6. Sanchez JL Jr, Craig SC, Kohlhase K, Polyak C, Ludwig SL, Rumm PD: Health assessment of U.S. military personnel deployed to Bosnia-Herzegovina for operation joint endeavor. Mil Med 2001; 166: 470–4.
7. Taylor SF: Health Assessment of Military Personnel Deployed to Operation Joint Endeavor. Interim Report. XX, U.S. Army Center for Health Promotion and Preventive Medicine, 1998.
8. Taylor SF, Lutz RH, Millward JA: Disease and nonbattle injury related to peacekeeping operations in South America: summary patient care statistics for CABANAS 2000. Mil Med 2001; 166: 1059–61.
9. McKee KT Jr, Kortepeter MG, Ljaamo SK: Disease and nonbattle injury among United States soldiers deployed in Bosnia-Herzegovina during 1997: summary primary care statistics for Operation Joint Guard. Mil Med 1998; 163: 733–42.
10. Sanders JW, Putnam SD, Frankart C, et al: Impact of illness and noncombat injury during Operations Iraqi Freedom and Enduring Freedom (Afghanistan). Am J Trop Med Hyg 2005; 73: 713–9.
11. Writer JV, DeFraites RF, Keep LW: Non-battle injury casualties during the Persian Gulf War and other deployments. Am J Prev Med 2000; 18: 64–70.
12. Statistic Information Analysis Division: Military Personnel Statistics, September 30, 2006. Available at http://siadapp.dmdc.osd.mil/personnel/MILITARY/Miltop.htm; accessed July 17, 2008.
13. Mander A, Clayton D: Update to hotdeck imputation. Stata Technical Bulletin 2000; 54: 199.
14. Blood CG, Gauker ED: The relationship between battle intensity and disease rates among Marine Corps infantry units. Mil Med 1993; 158: 340–4.
15. Lorich MF, Marshall M, Walker WT, Clark SE, Rene A, Ivanovskis G: Line-of-duty injury or illness in an Air National Guard unit. Mil Med 2002; 167: 732–5.
16. Bell NS, Mangione TW, Hemenway D, Amoroso PJ, Jones BH: High injury rates among female army trainees: a function of gender? Am J Prev Med 2000; 18: 141–6.
17. Harman DR, Hooper TI, Gackstetter GD: Aeromedical evacuations from Operation Iraqi Freedom: a descriptive study. Mil Med 2005; 170: 521–7.